

Initial ADS-B Observations

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Raytheon Systems Limited

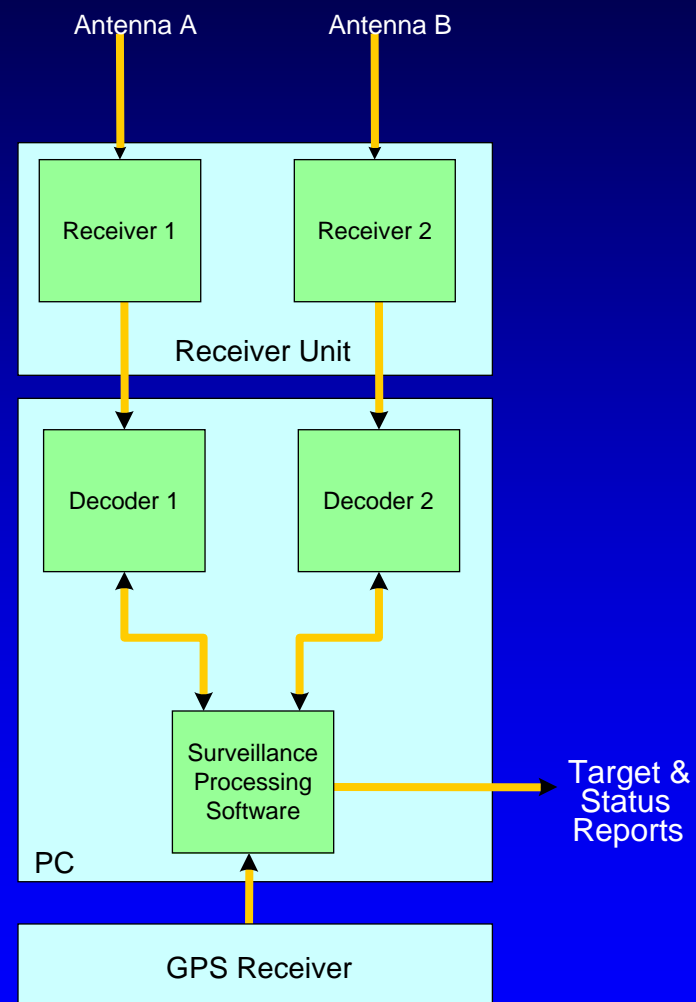
7th December 2005

Presentation Overview

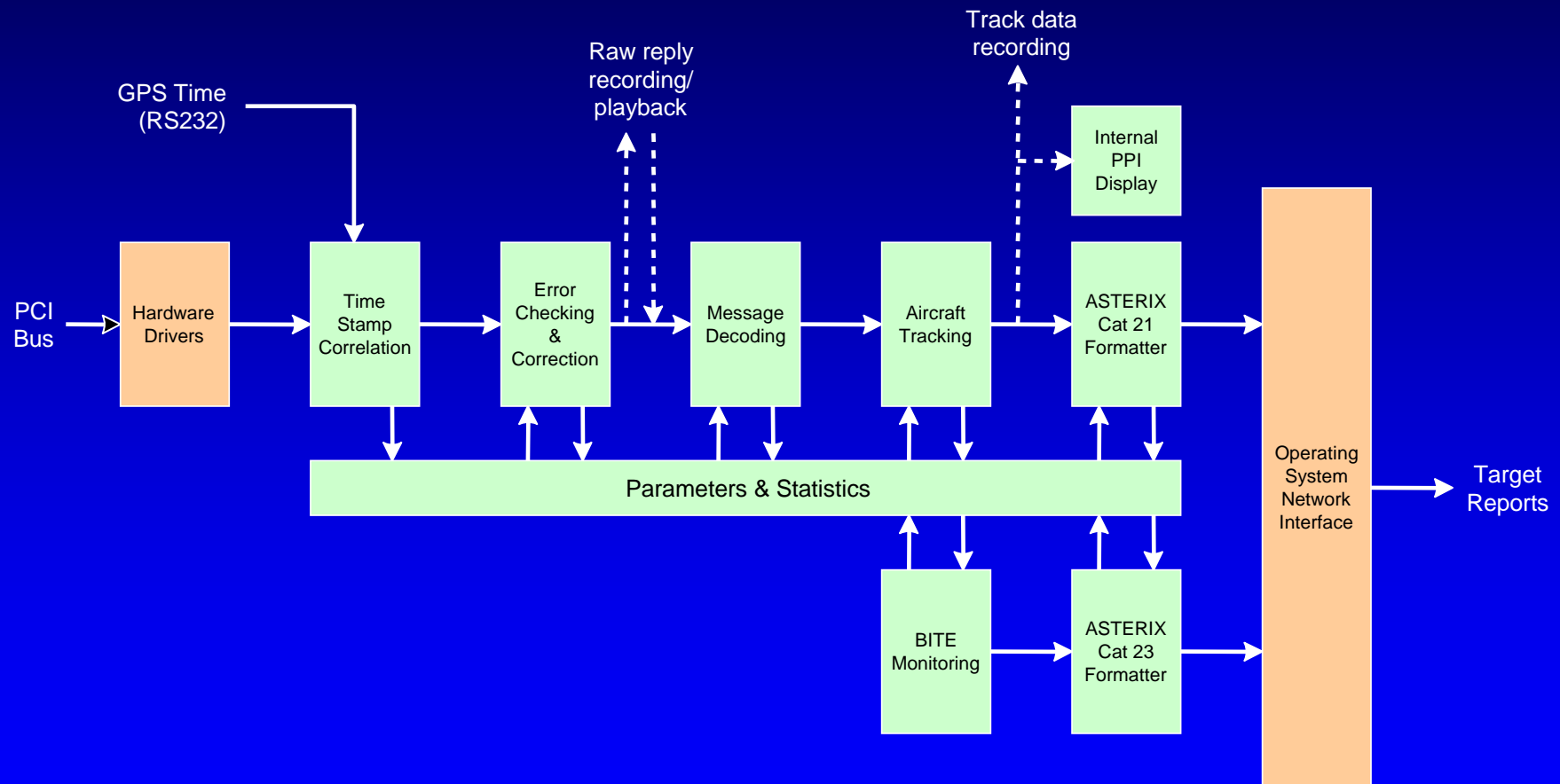
- Overview of Raytheon ADS-B demonstrator
- Trials and initial results
- Levels of Equipage
- Observations

Overview of Raytheon ADS-B Demonstrator

Demonstrator Hardware Architecture



Software Architecture



Trials and Initial Results:

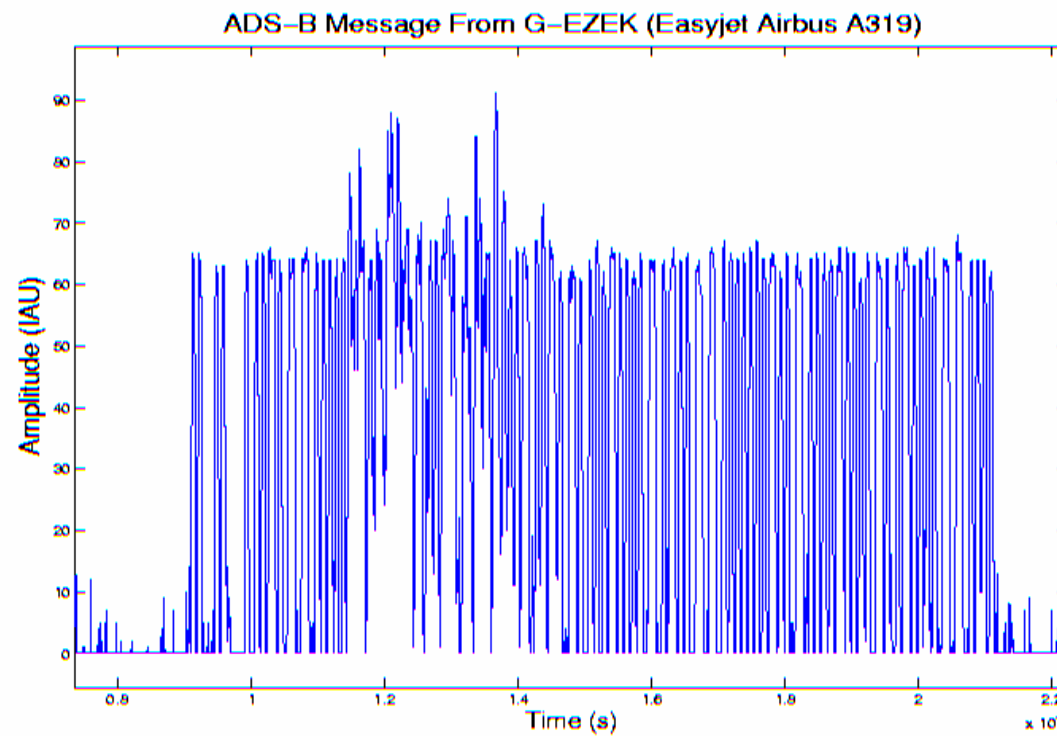
Harlow, UK

Harlow Antenna Configuration



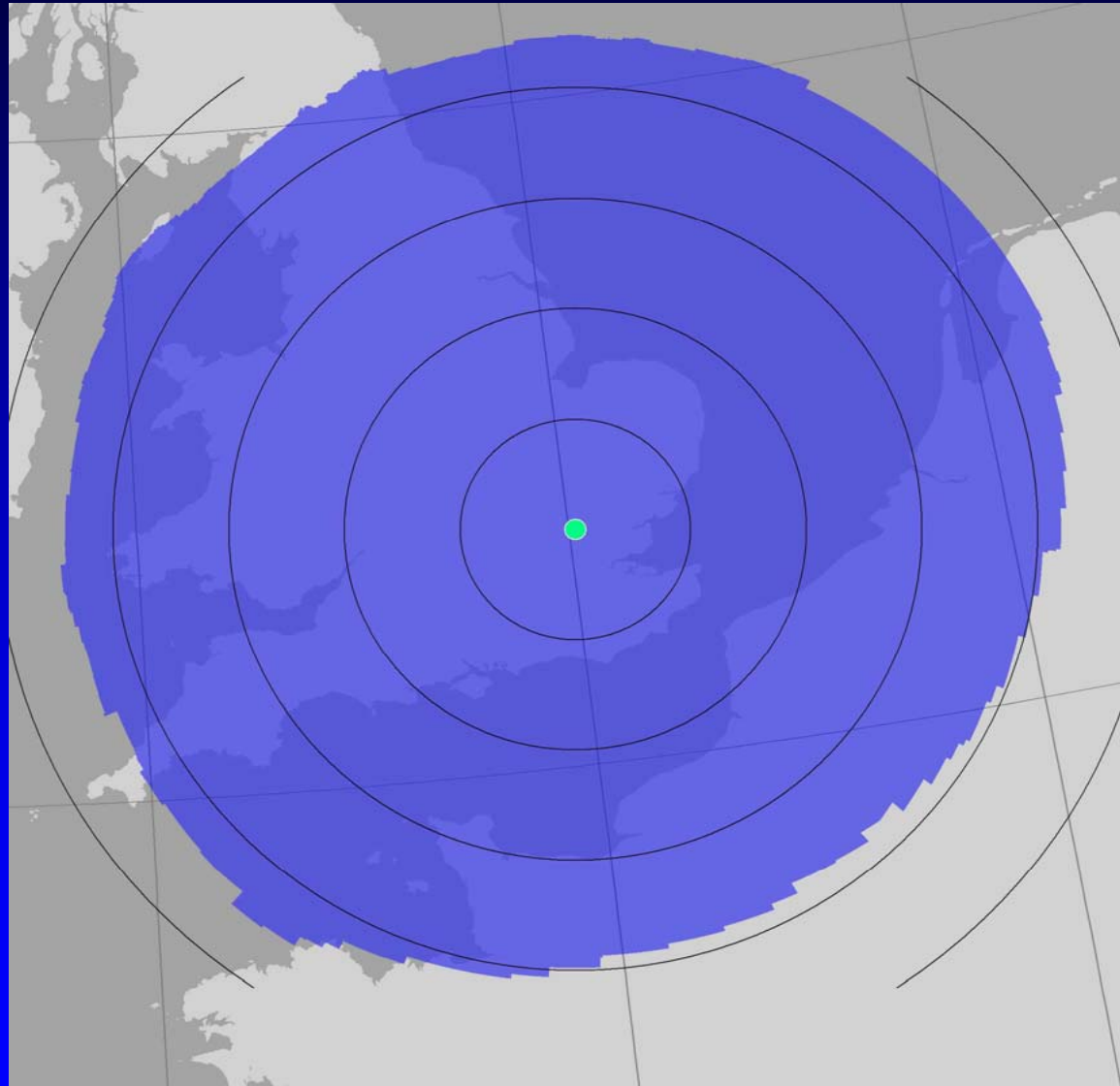
- The antenna comprises two columns from our LVA antenna in a back-to-back configuration.
- This gives 360° of coverage.
- Each of the columns is fed into its own receiver / decoder channel.
- N-type connectors are used, allowing system performance to be evaluated with any standard antenna.

First Received Message at Harlow

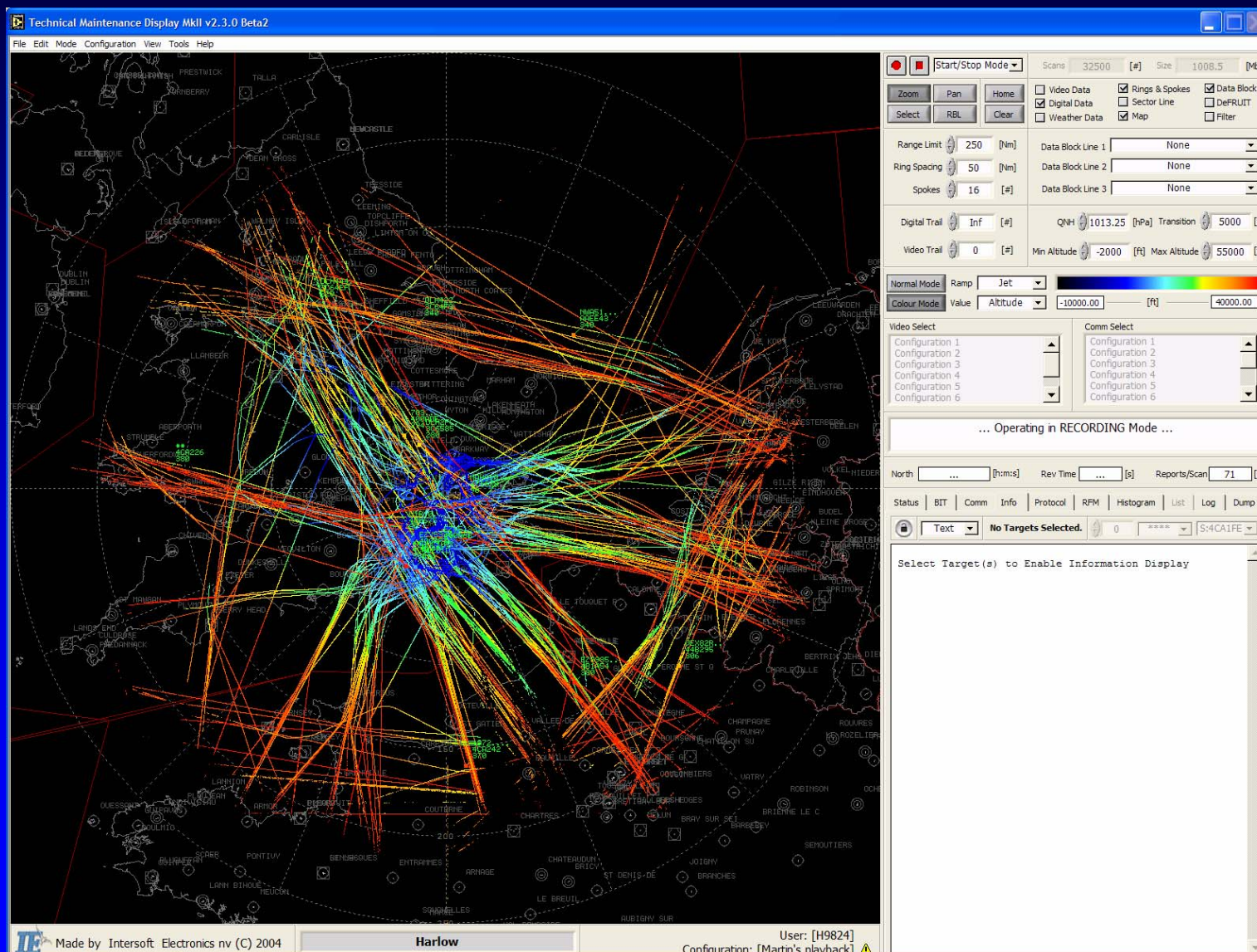


Predicted Coverage from Harlow at 37,000 feet.

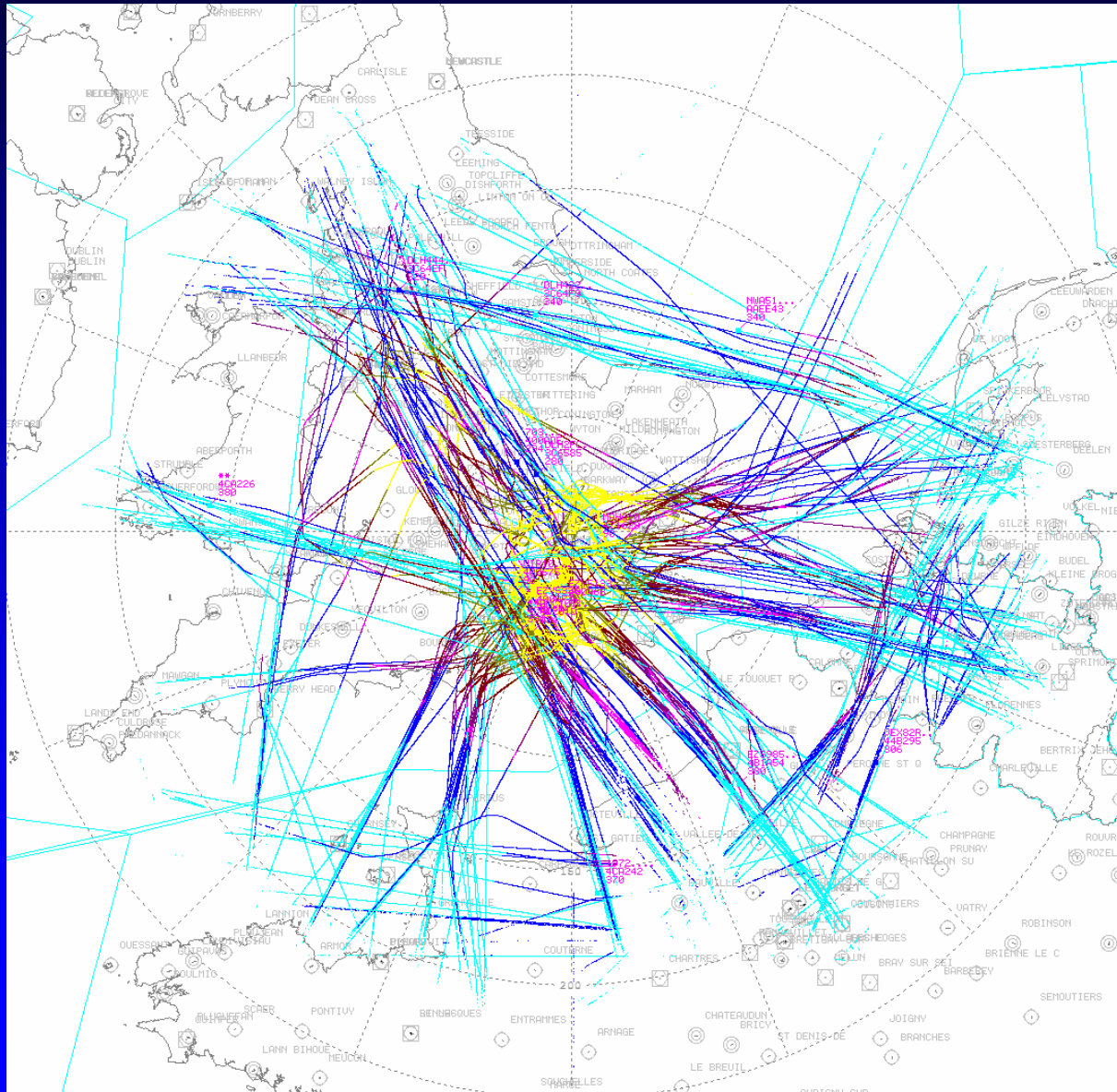
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ADS-B Coverage from Harlow



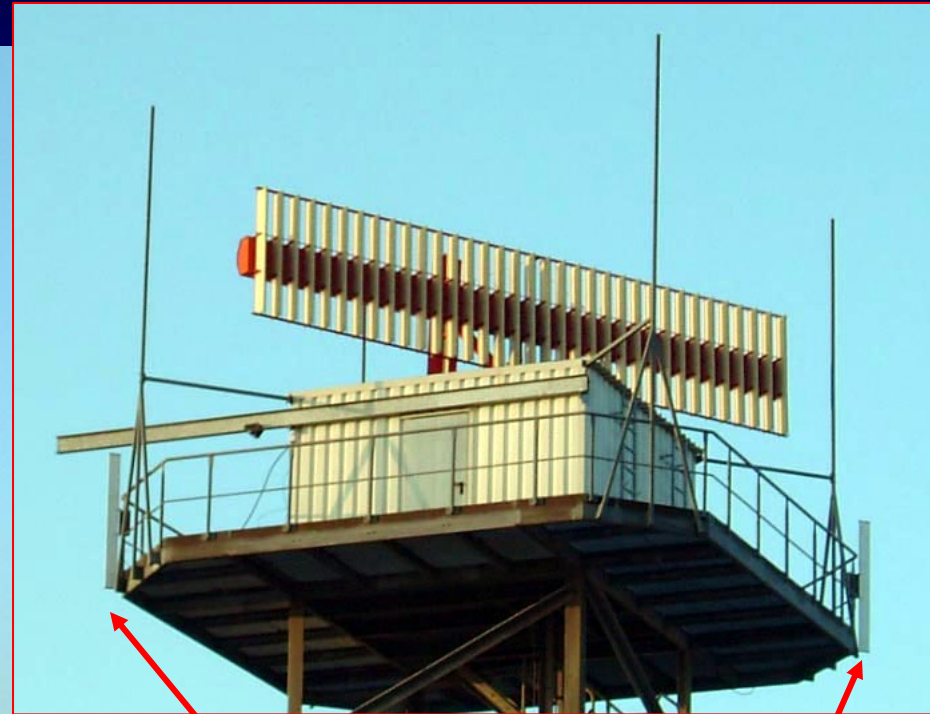
ADS-B Coverage from Harlow



Trials and Initial Results:

Götzenhein, Germany

Götzenhein Antenna Configuration



At Götzenhein the ADS-B antenna elements have been positioned either side of the tower for 360° coverage.

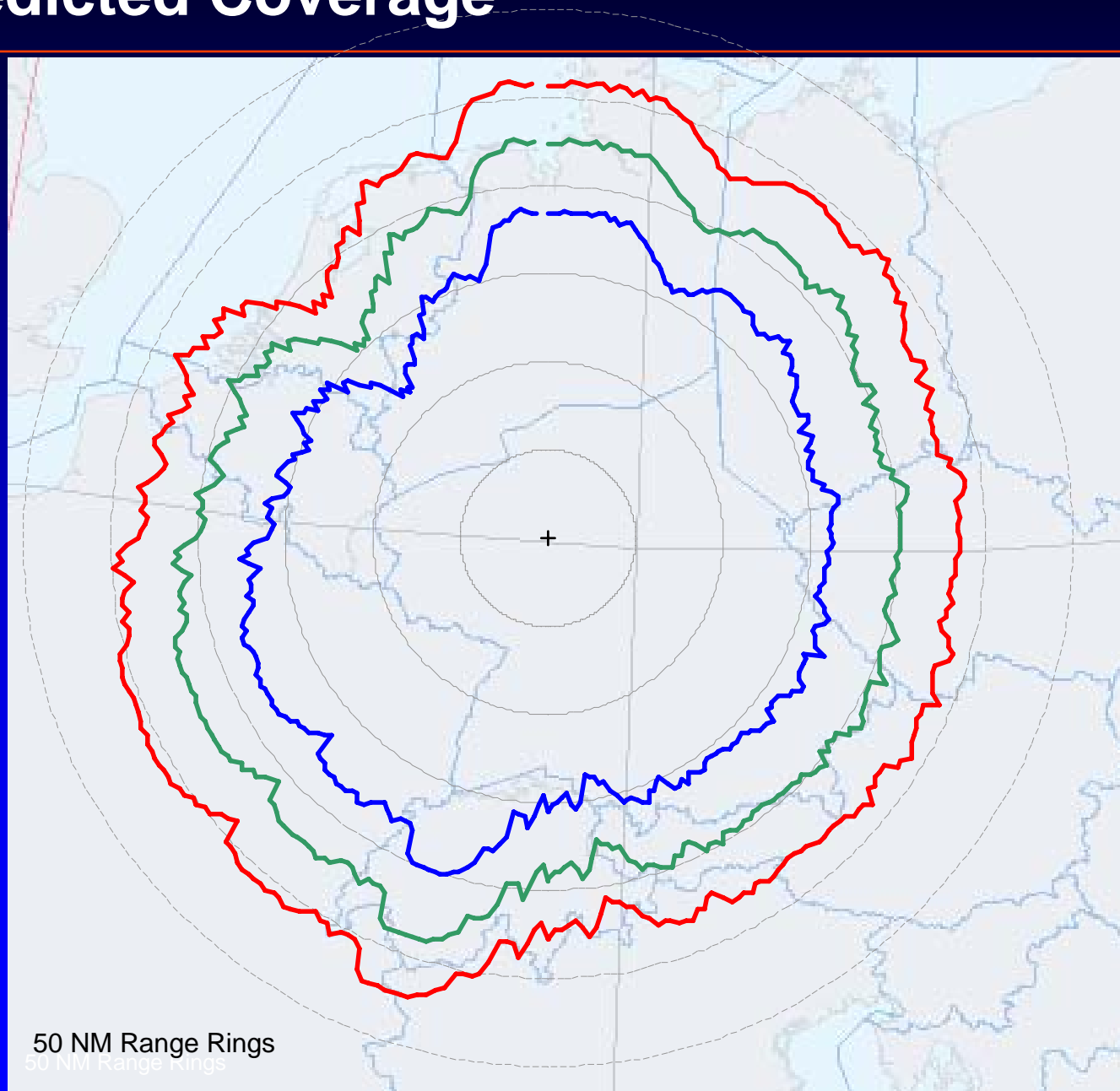
Götzenhein Predicted Coverage

Götzenhein Coverage

20,000 ft

30,000 ft

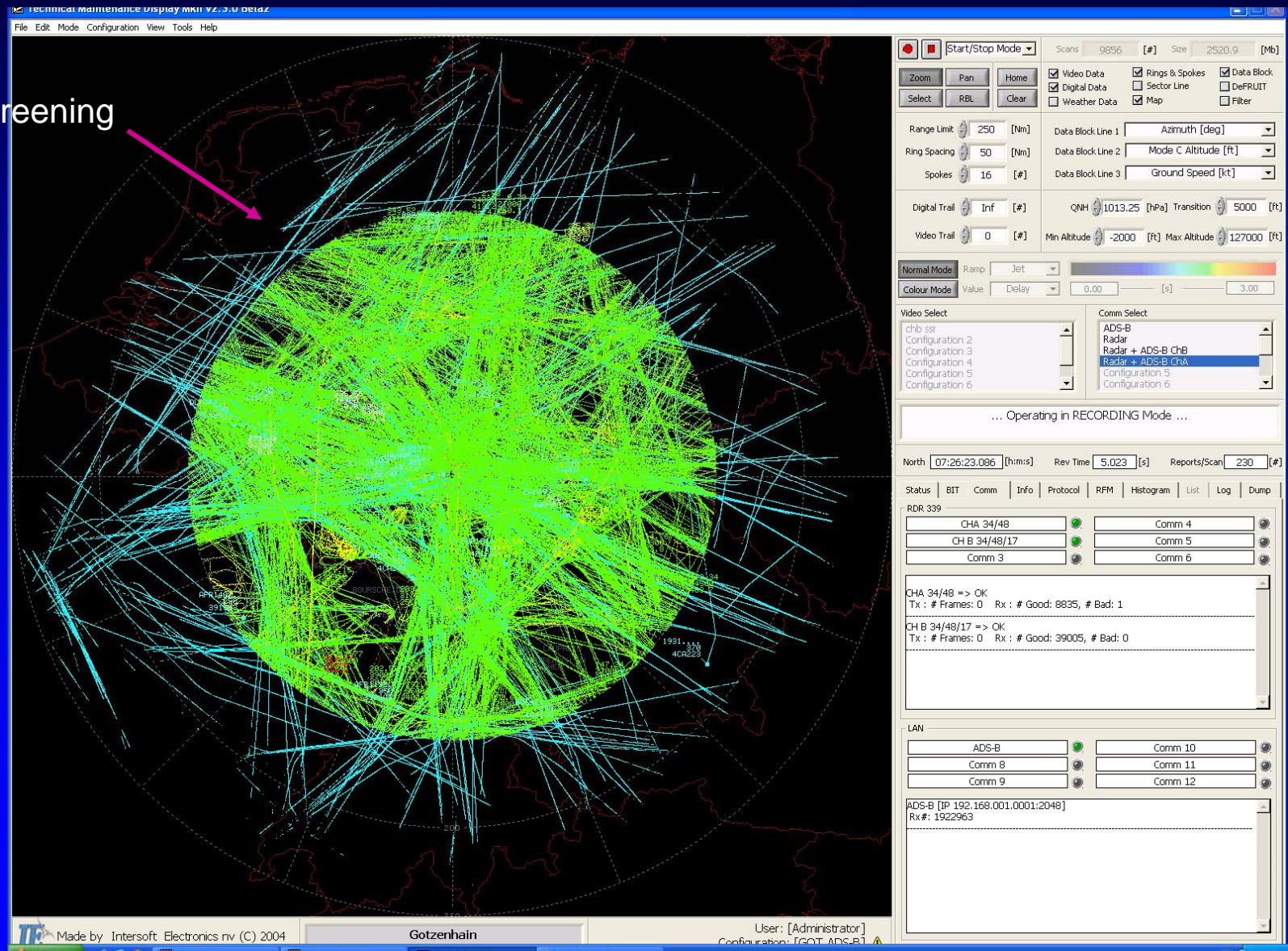
40,000 ft



Götzenhein Radar and ADS-B Data

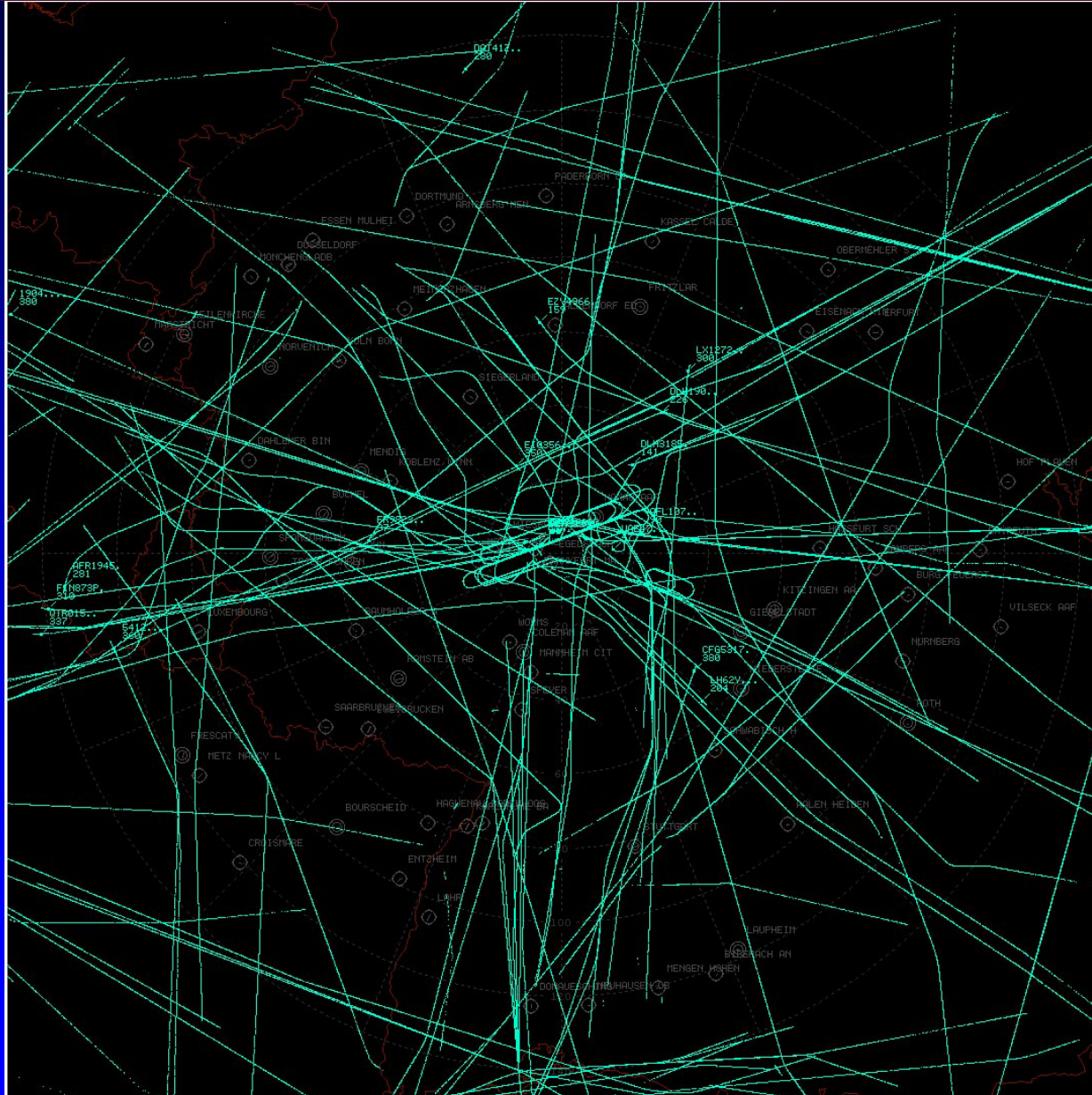
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Terrain Screening



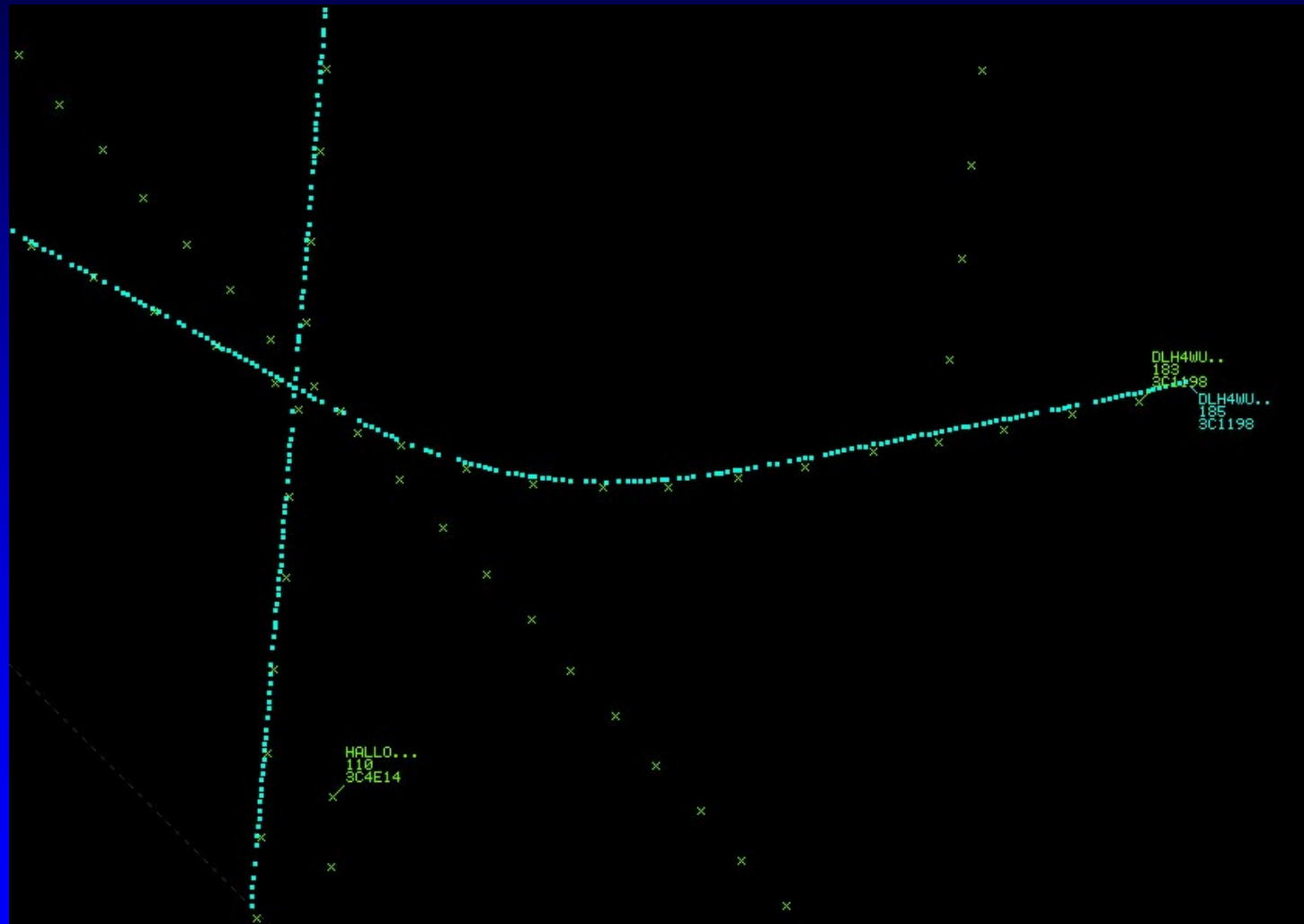


ADS-B Coverage to 150 NM



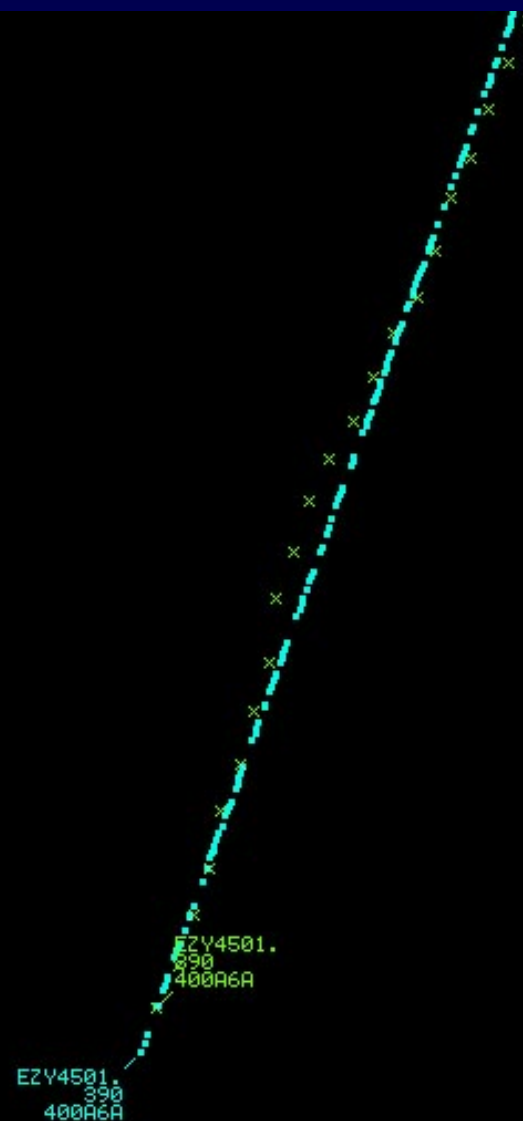


Radar and ADS-B Update Rates



The radar was rotating at 12 rpm (5 second update)

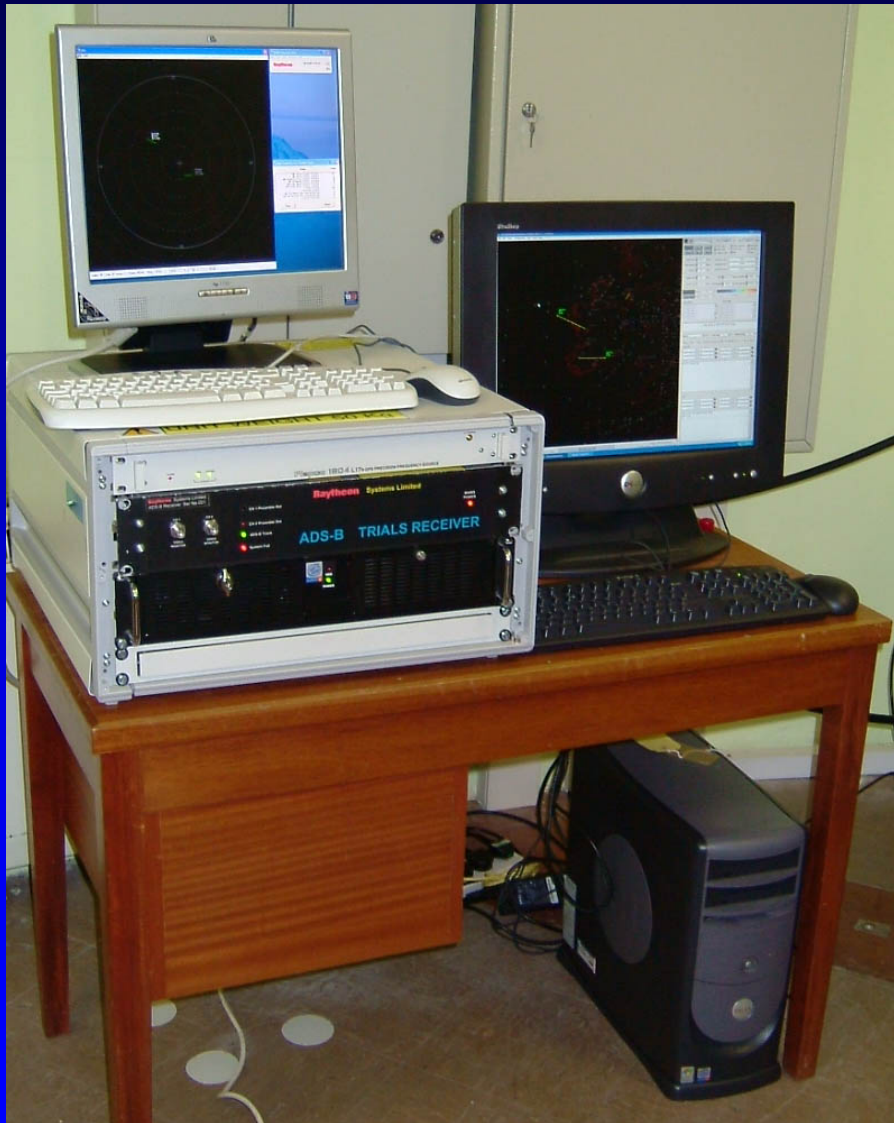
Radar - Site Effects



Trials and Initial Results:

Woodcock Hill, Ireland

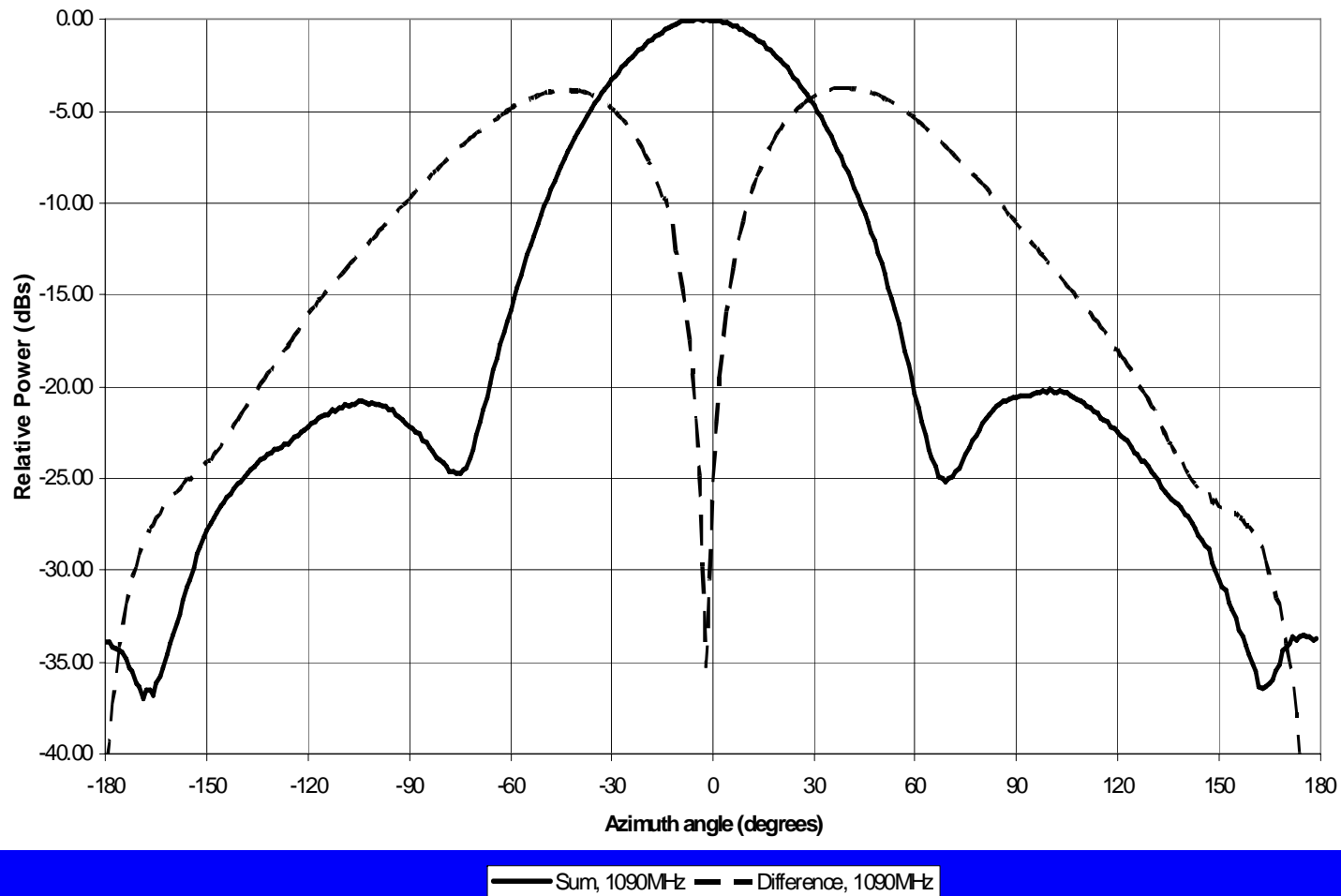
ADS-B Equipment at Woodcock Hill



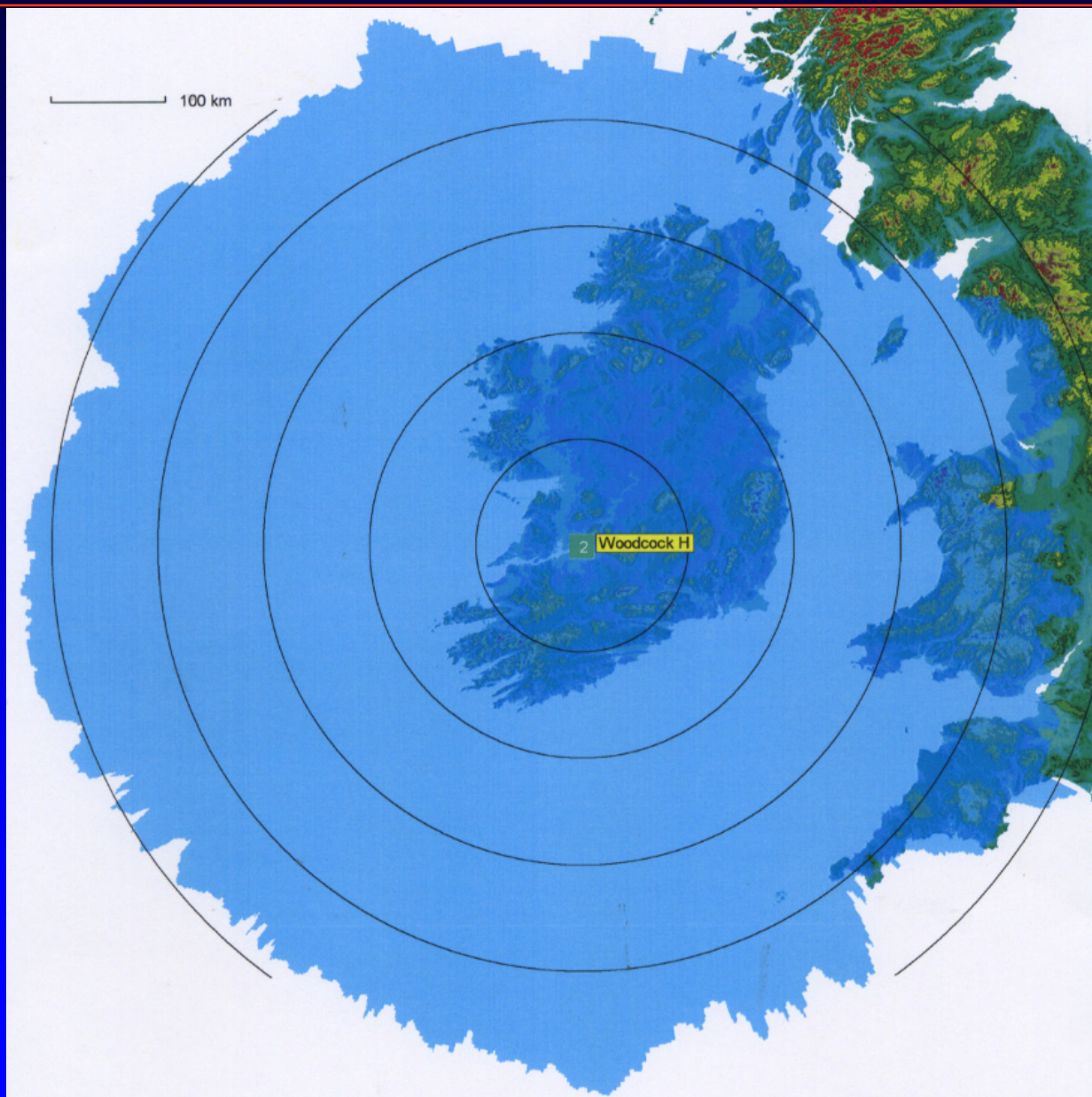
ADS-B Sector Antenna

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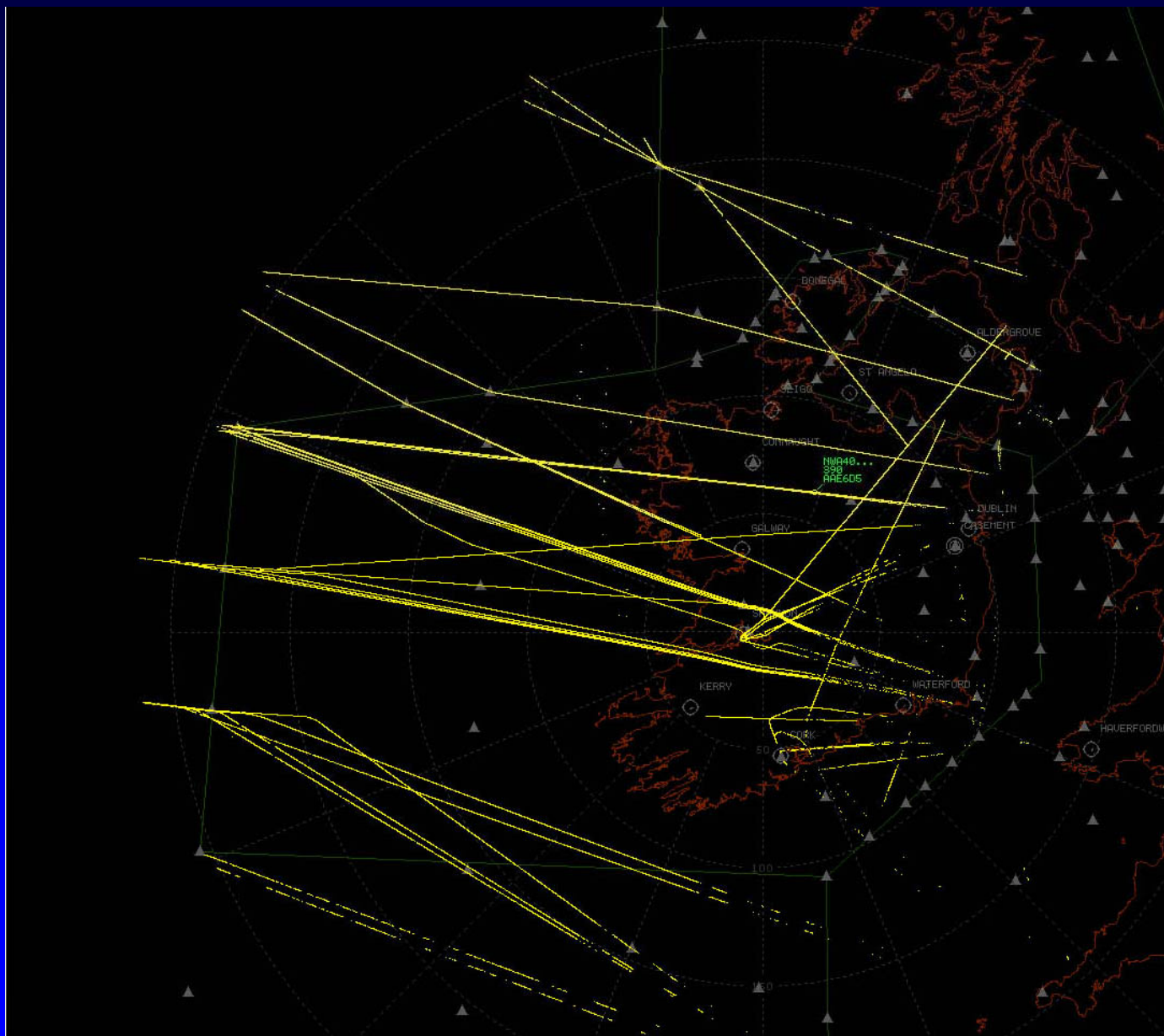
ADS-B Sector Antenna, Measured azimuth patterns
at Elevation Beam Peak



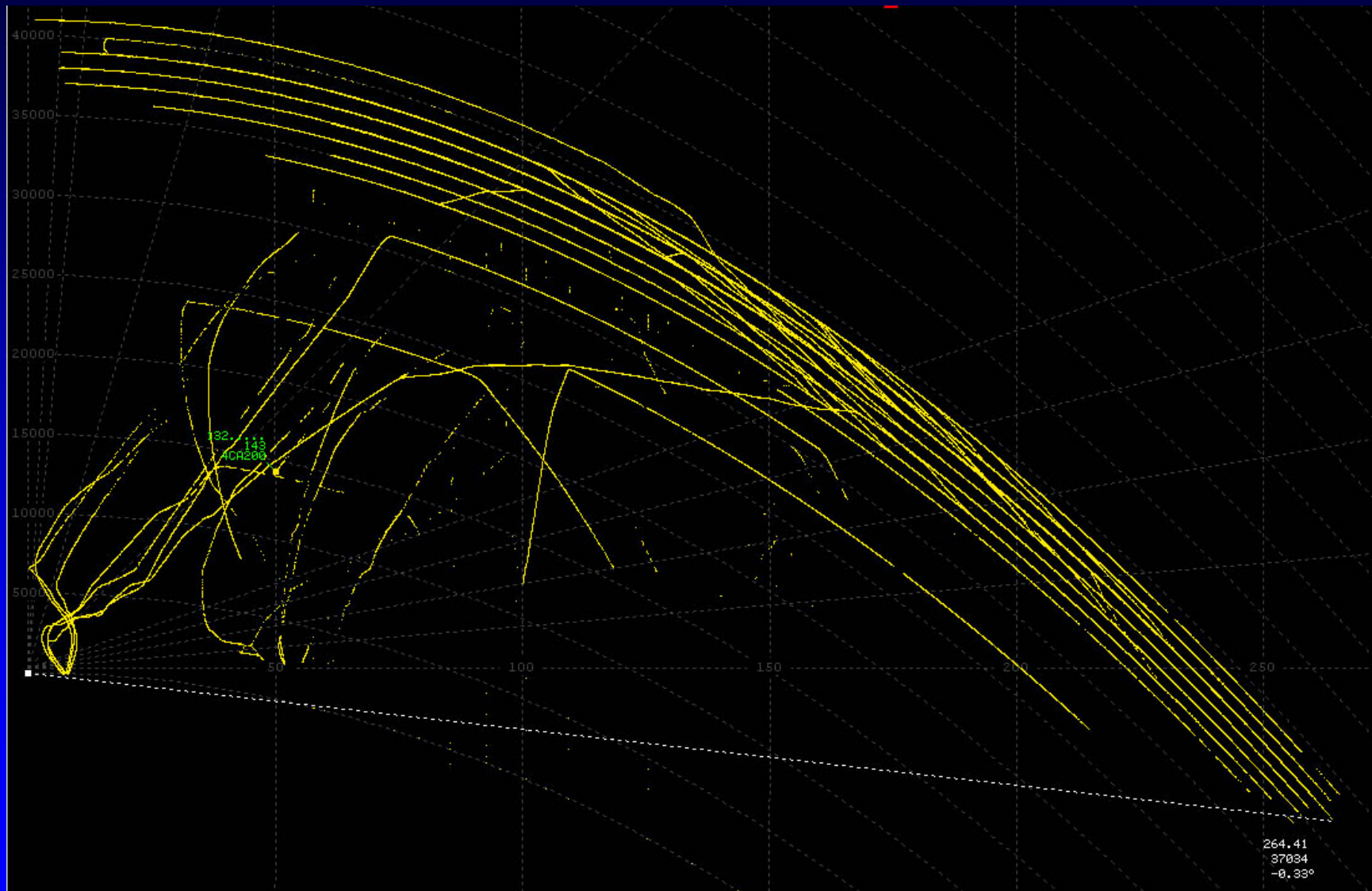
Predicted Coverage at 37,000 ft.



Sector Antenna Coverage from Woodcock Hill



ADS-B Coverage from Woodcock Hill



Back-to-Back Antenna Configuration



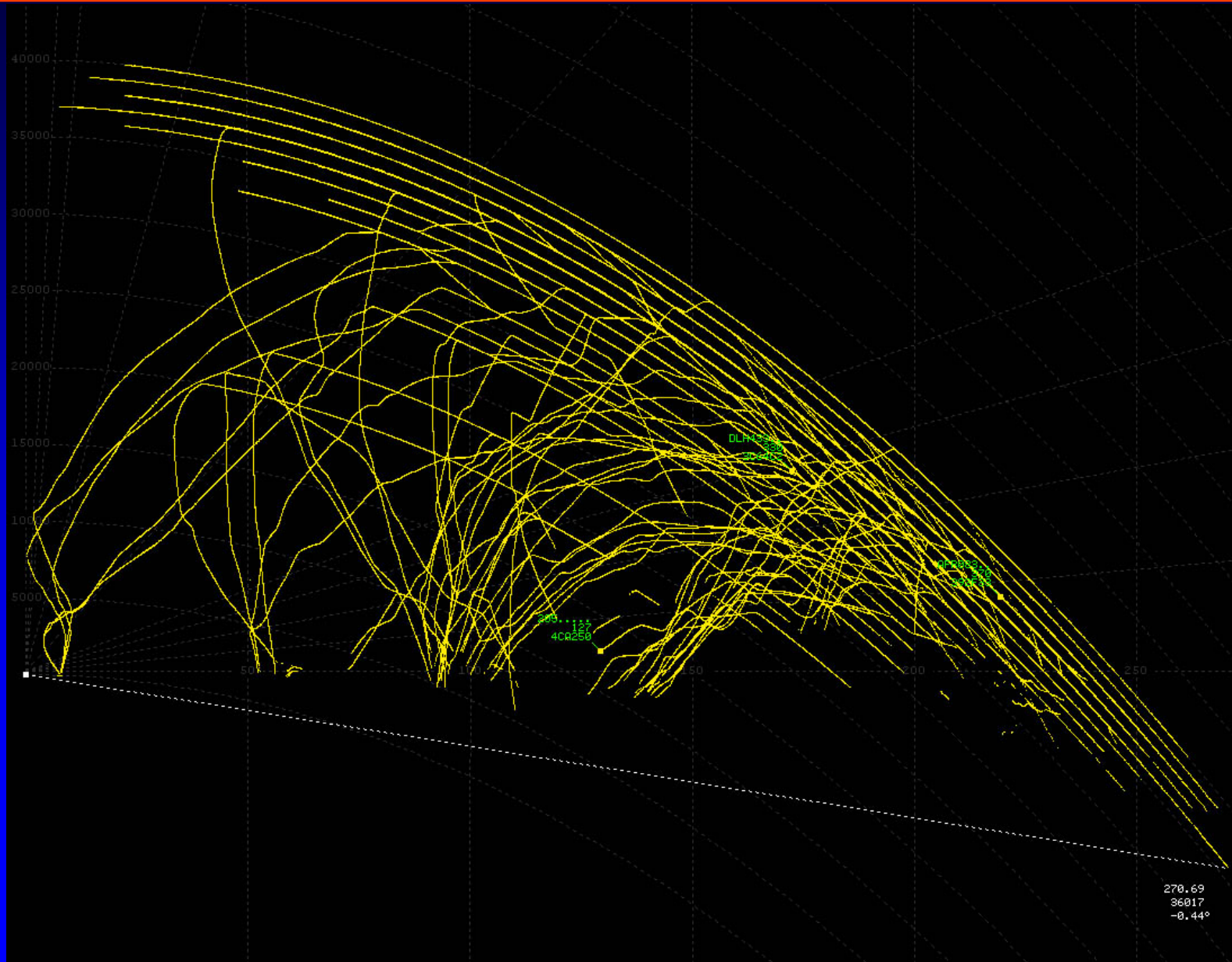
- The antenna comprises two columns from our LVA antenna in a back-to-back configuration.
- This gives 360° of coverage.
- Each of the columns is fed into its own receiver / decoder channel.

Back to Back Antenna Coverage from Woodcock Hill

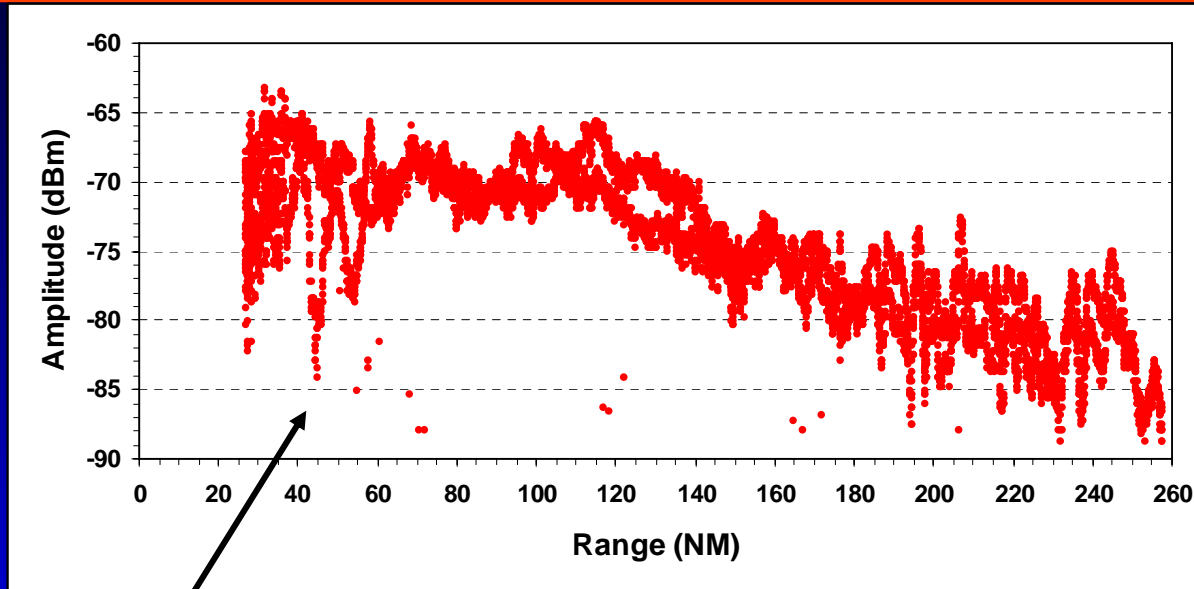
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Individual Aircraft R/A Plots

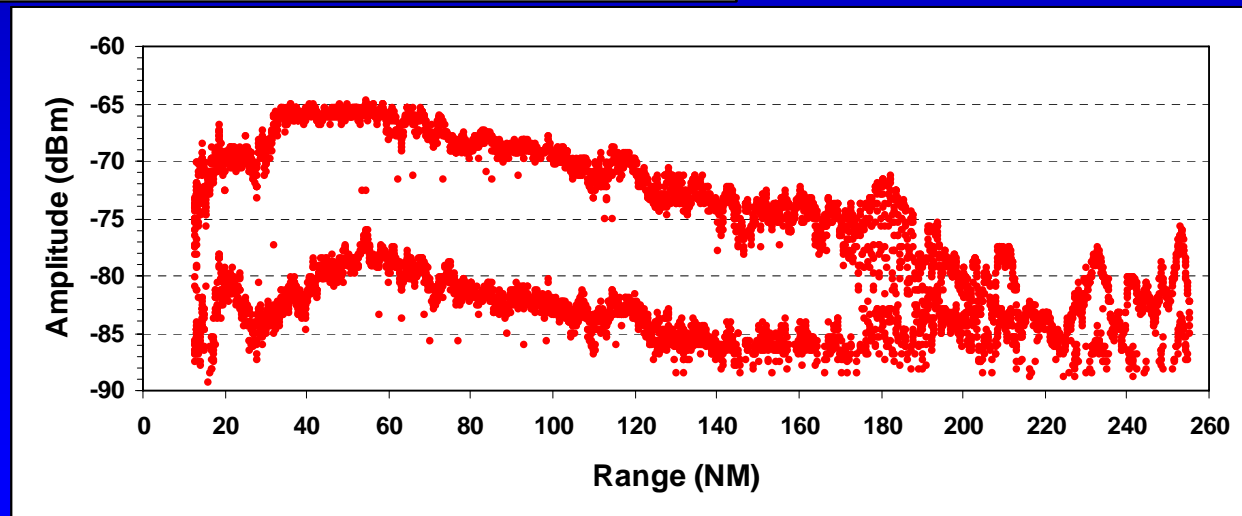


BA Outbound

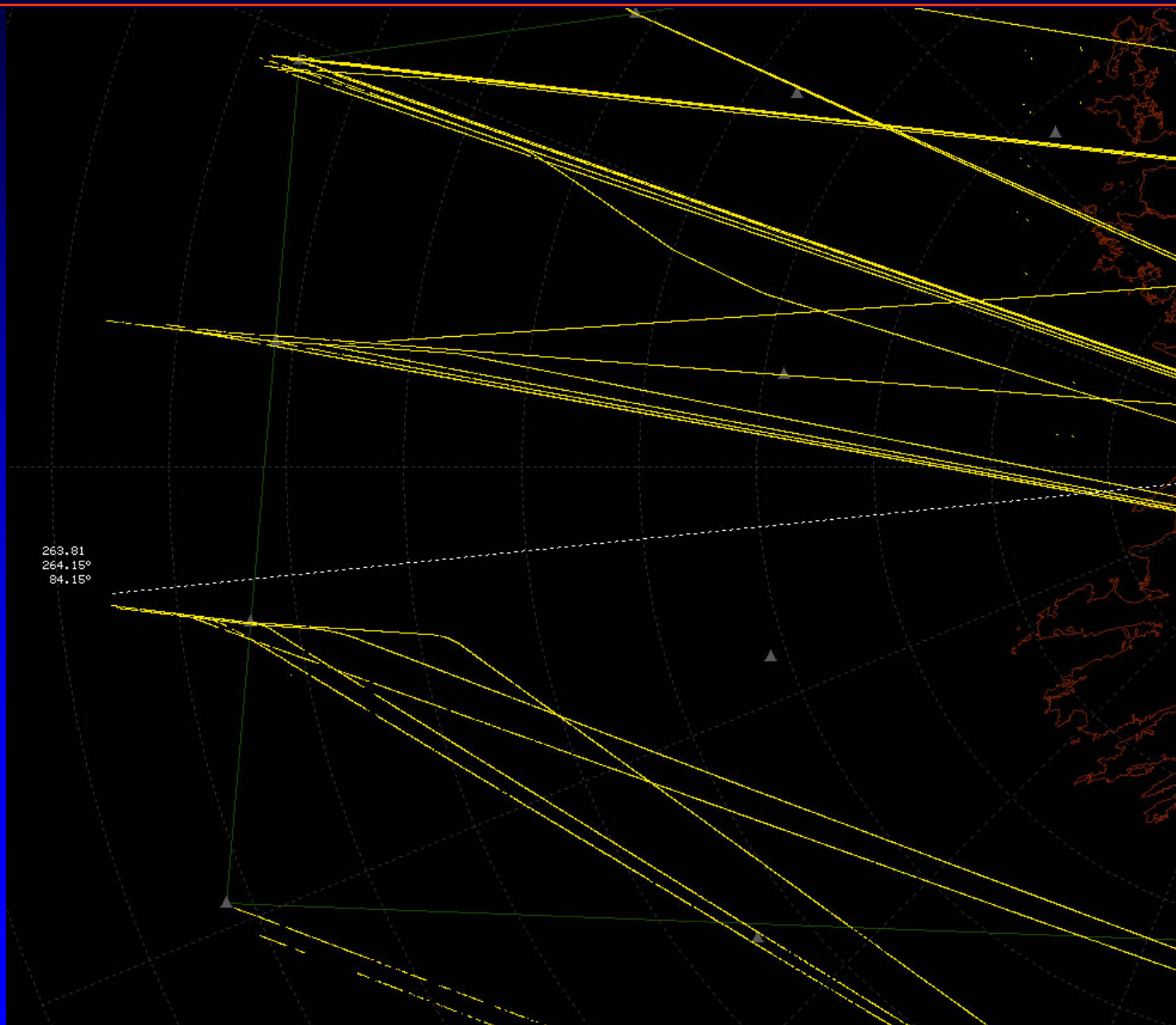
Virgin Inbound

Aircraft Climbing

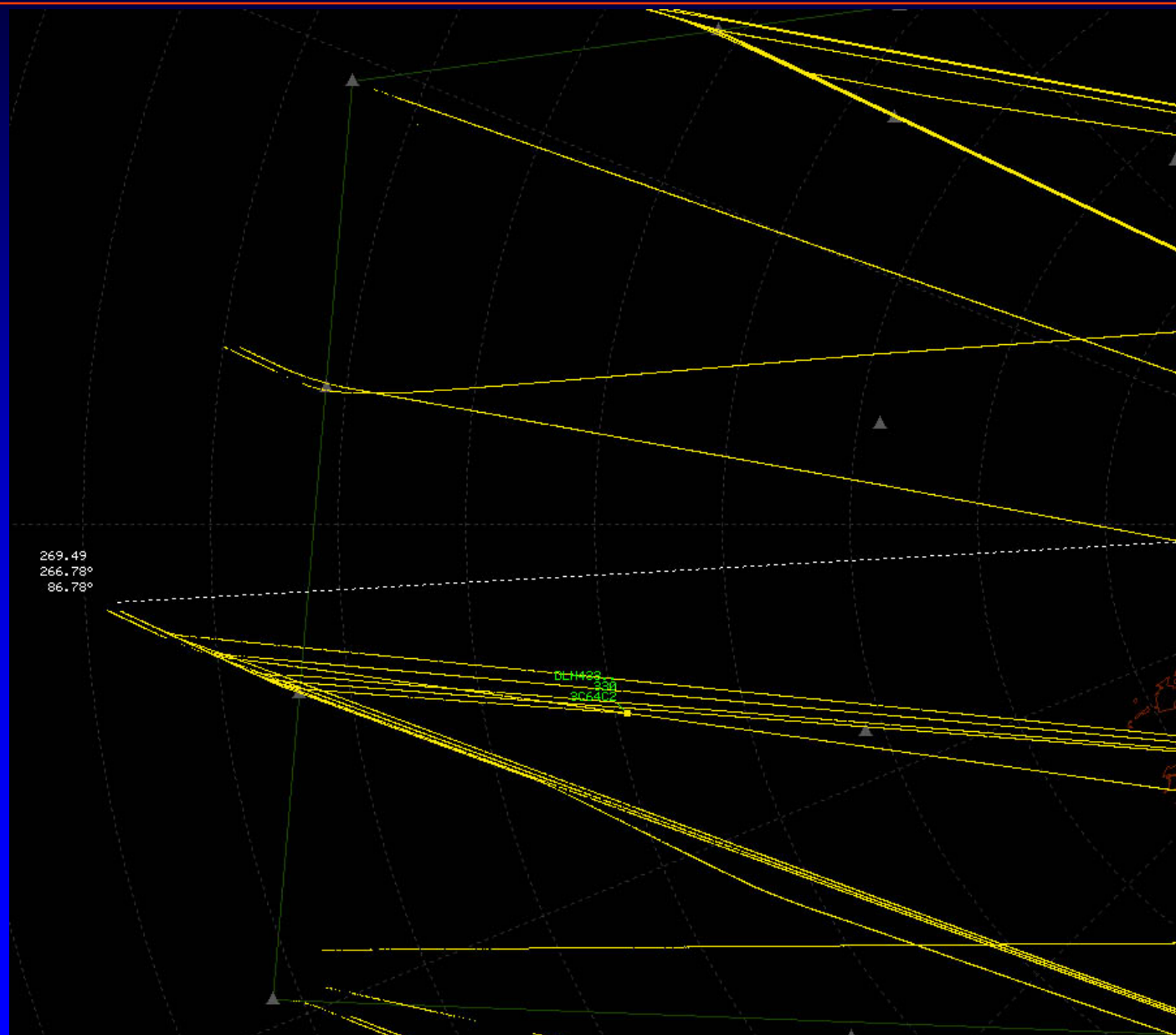
Aircraft Squitter
alternately from
the top and
bottom antenna.



Coverage at 15W - Sector Antenna



Coverage at 15W - Back to Back Antenna



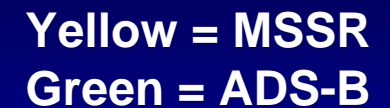
Trials and Initial Results:

Les Platons, Jersey

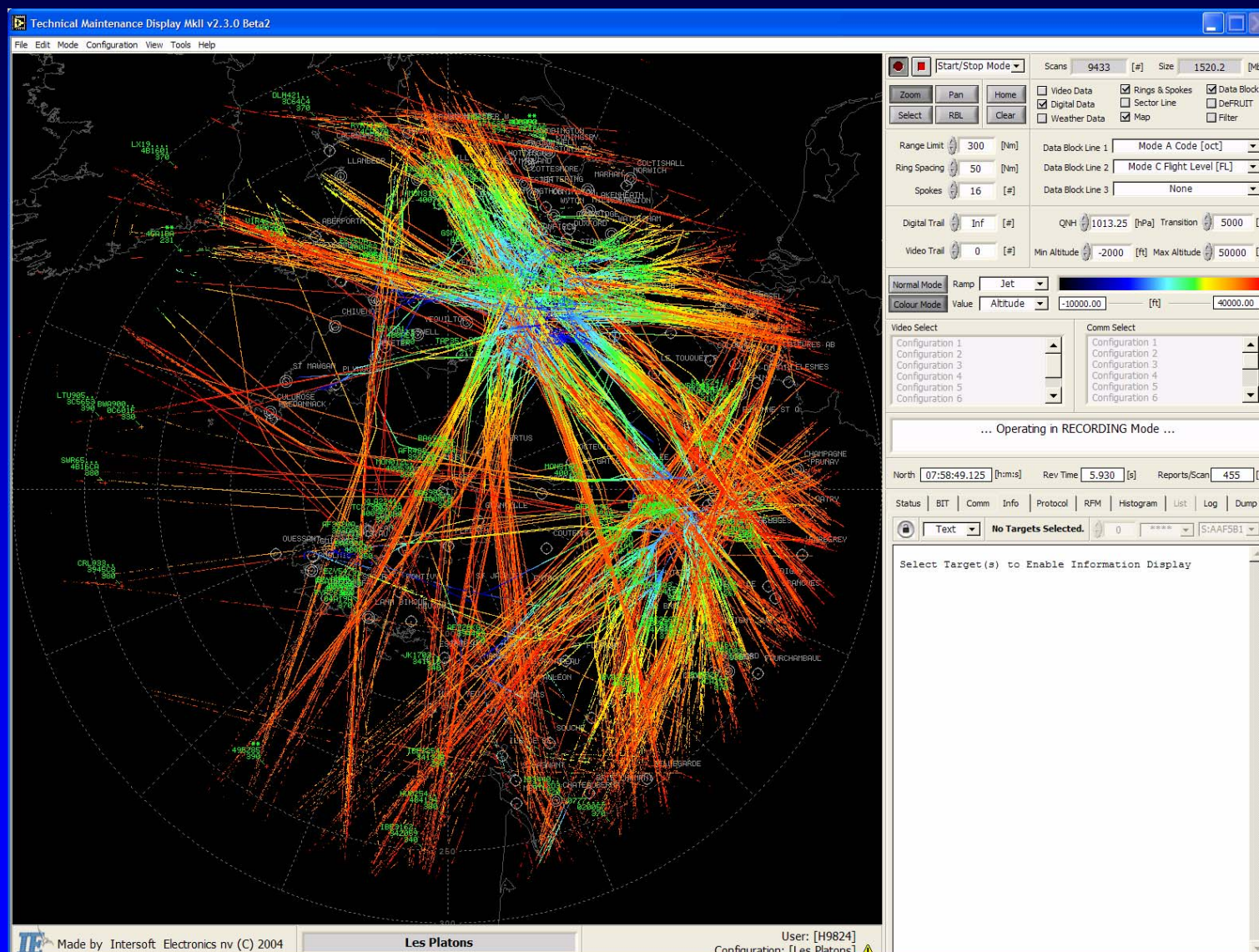
Jersey Antenna Configuration



The ADS-B antenna elements have been positioned either side of the tower for 360° coverage.

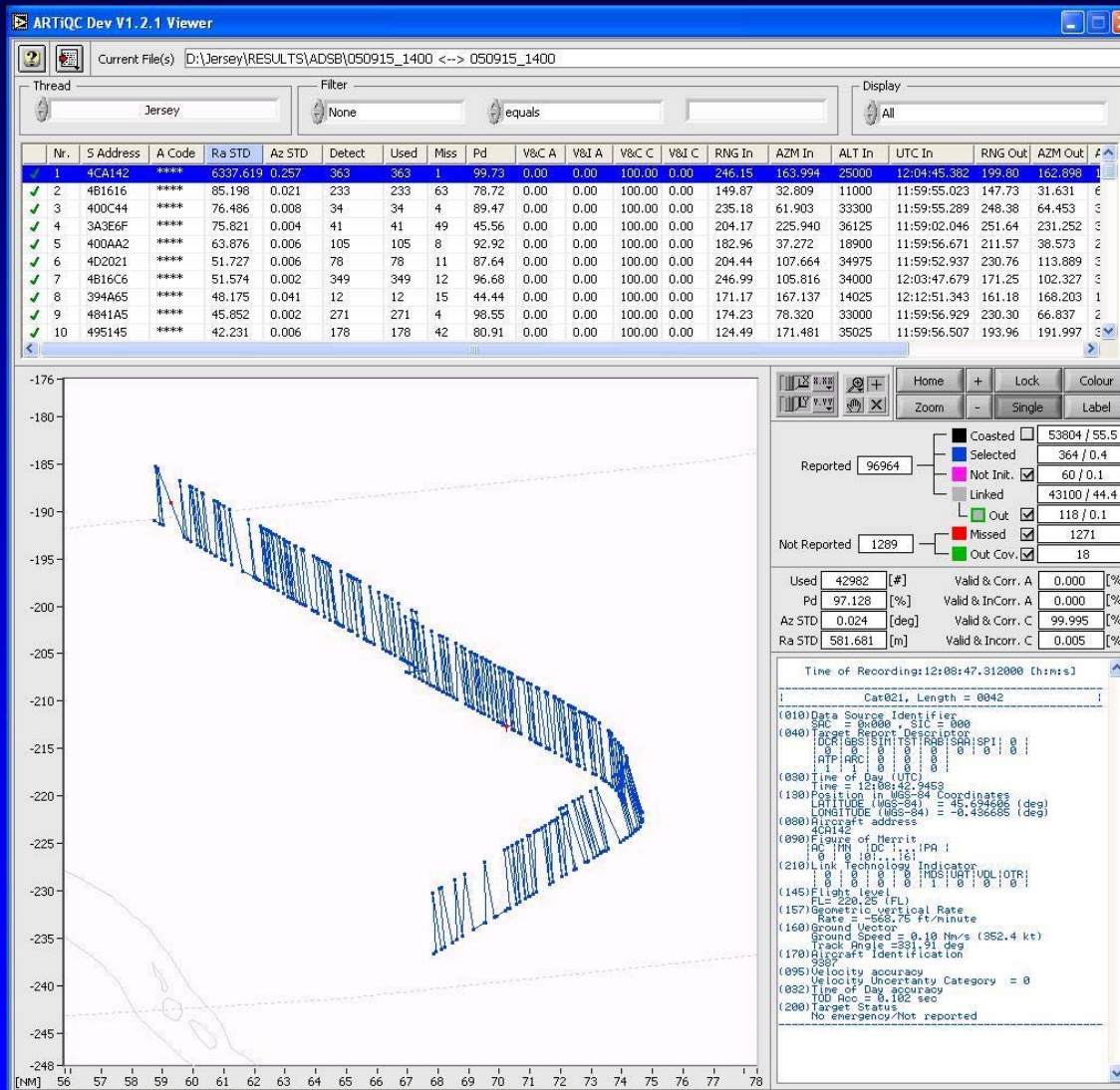


Jersey Coverage Volume – Overnight Plot



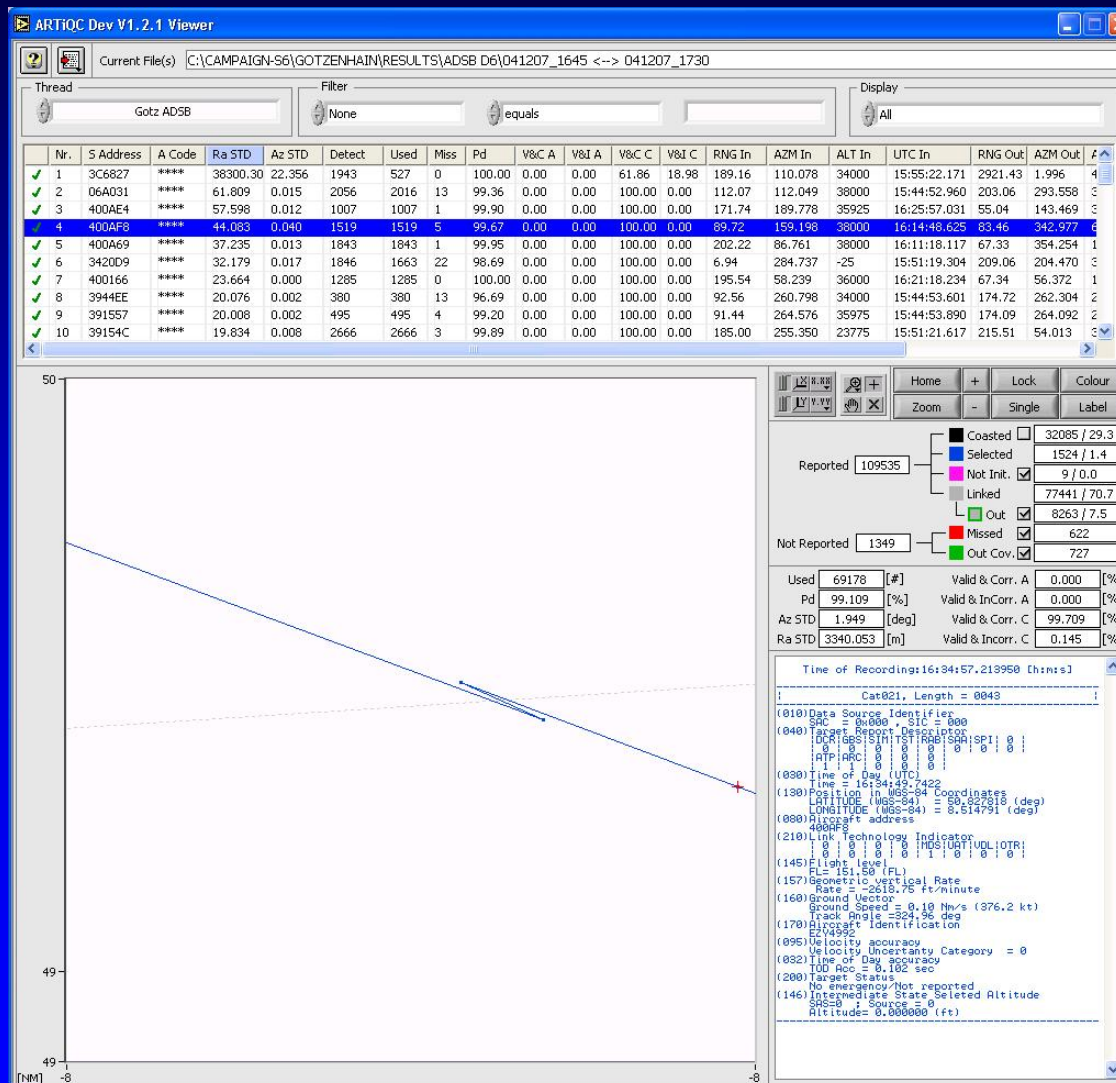
Observations

CPR Decoding Problems



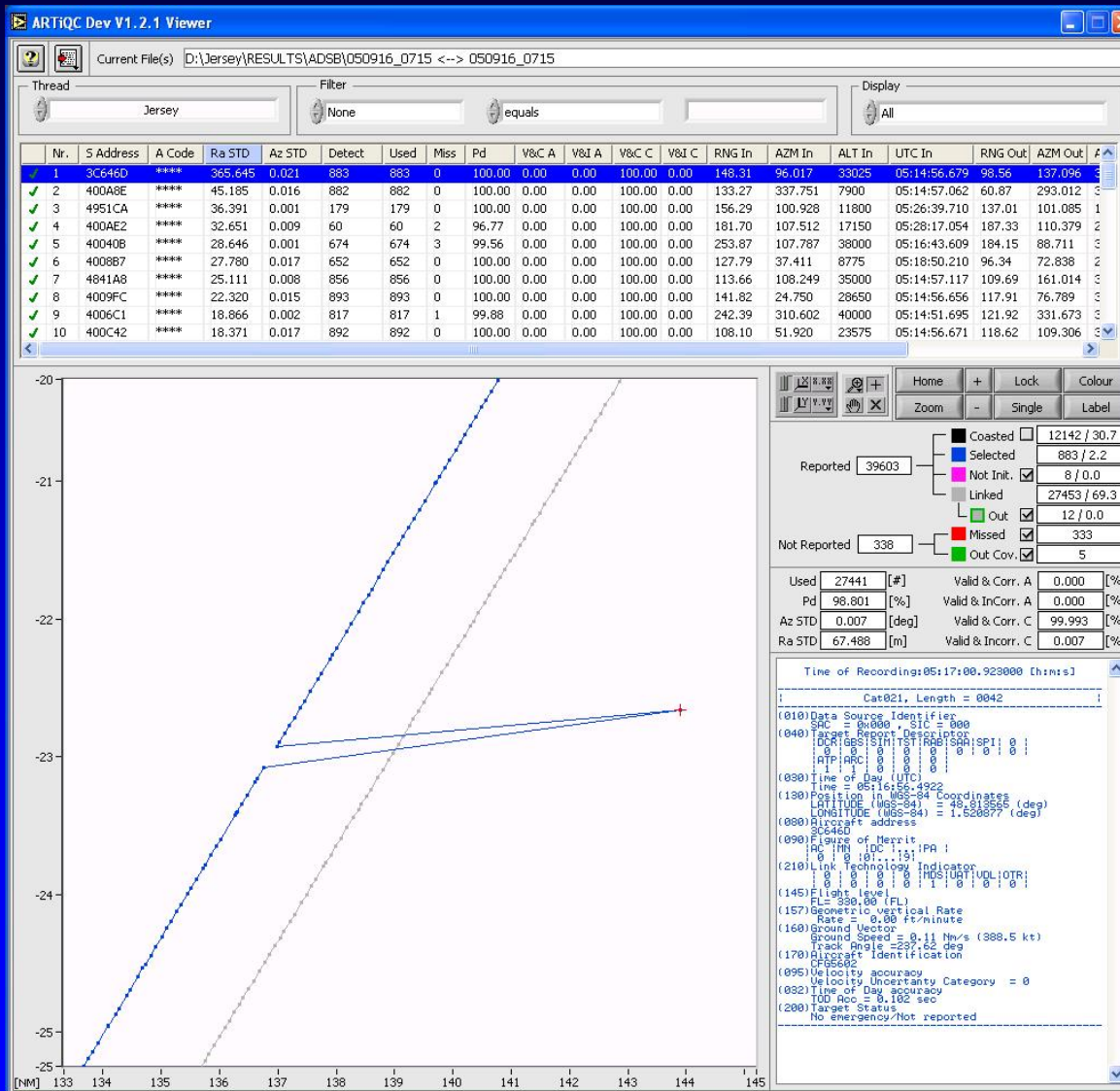
- Three tracks were observed to have bad position probably caused by an odd/even CPR correlation error.
- Two of these events were caused by the same aircraft.

Incorrect Plot Sequence



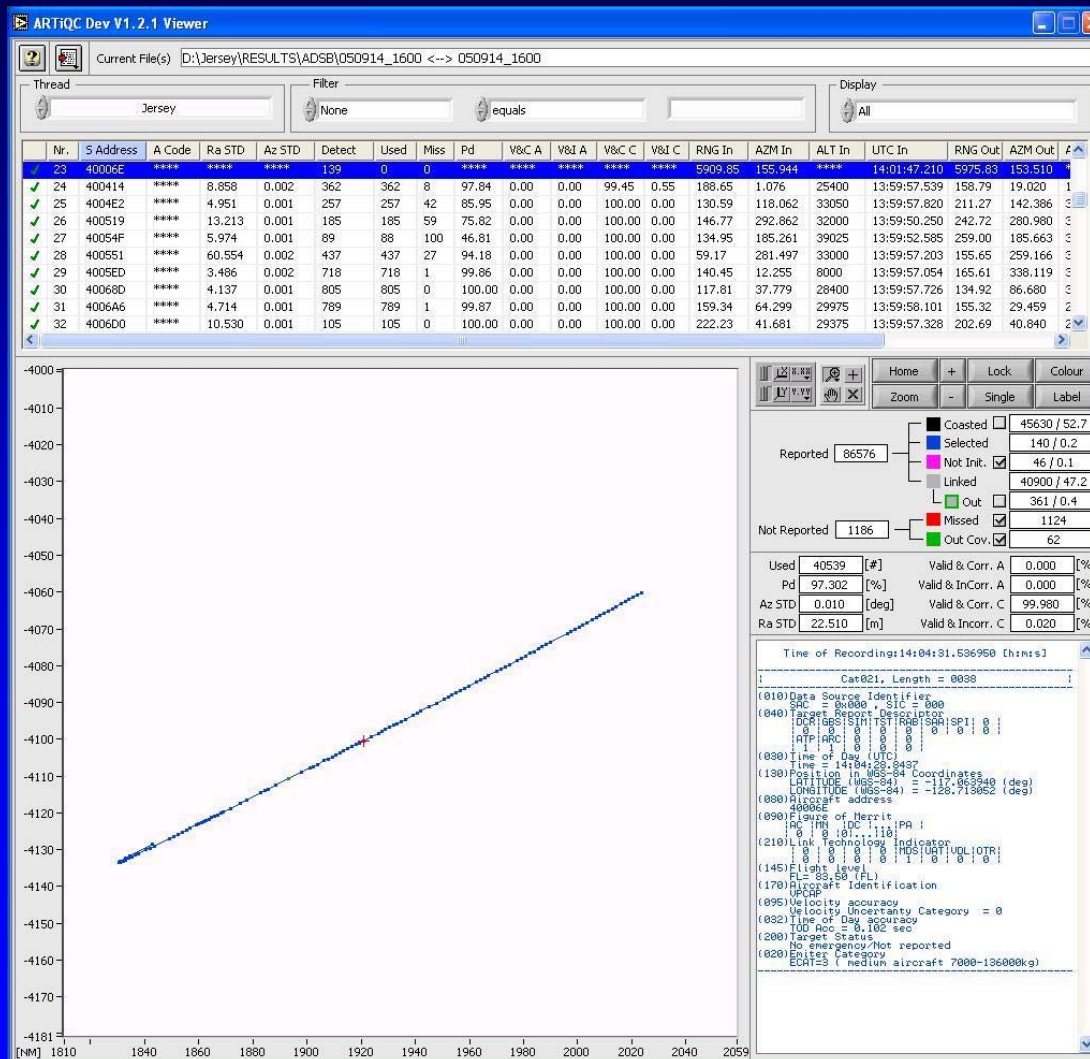
- Some aircraft appeared to output plots out of sequence.
- This effect was limited to a few aircraft.

Incorrect Position Plot

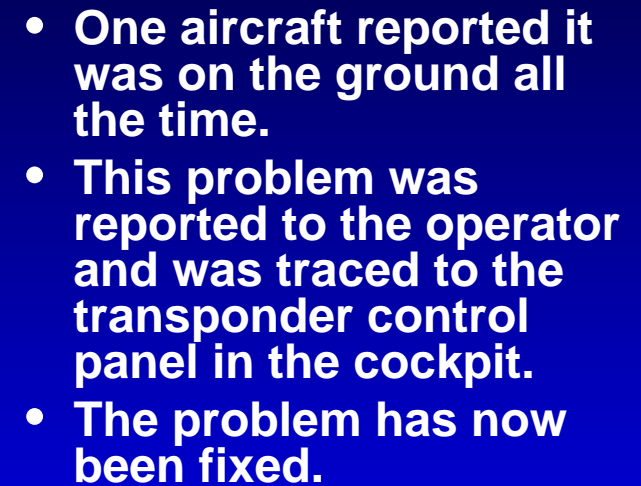


- Very occasionally a plot was output in the wrong place.
- It is thought that this was a result of an incorrect error correction operation.
- This type of error is easy to detect and suppress (but the demonstrator deliberately does not do this).

Continuously Incorrect Position



- One aircraft constantly reported a bad position.
- The track looks good on the face of it.



Summary

Summary

- Around half of all commercial aircraft are transmitting valid ADS-B messages. (This was around 10% a year ago.)
- Most of the rest are transmitting extended squitters, but without valid position data.
- Some aircraft transmit INS / FMS position which seems to be up to 2 miles away from the correct position, but these aircraft ALL seem to transmit a low figure of merit.
- The number of transponders transmitting incorrect data is very low (<1%).
- Very few aircraft (<5?) are transmitting false information and reporting it as valid.